regular US
application

TITLE OF THE INVENTION

Anticollision Light for Aircraft

BACKGROUND OF THE INVENTION

Field of the Invention

The invention relates to an anticollision light for aircraft and particularly for airplanes and helicopters.

Description of Related Art

It is known to provide lights in the exterior portion of an aircraft, e.g., position lights and anticollision lights, with incandescent lamps (either with heating spiral or as electric discharge lamps) (U.S. Patent No. 5,293,304). Such incandescent lamps have a relatively short life and are particularly susceptible as to vibrations.

Therefore, one goes more and more over to use light-emitting diodes (LEDs) for the outer illumination of airplanes, namely in the form of individual LEDs or LED modules comprising a semiconductor chip with a plurality of light-emitting portions. Examples therefor can be found in WO-A-95/19525, WO-A-95/23313, WO-A-97/29320, WO-A-99/59869, European Patent No. 1 231 109, GB-A-2 337 645, U.S. Patent No. 2002/0101189 and US-B-6,244,728.

A certain disadvantage of the use of LEDs lies in their spatially limited light radiation angle (normally over solid angles of 120° to 140°), whereas incandescent lamps emit light in the entire space. In exterior lights of airplanes or aircraft equipped with incandescent lamps, this light is directed into the desired preferred direction by means of reflectors to satisfy the internationally and respectively nationally valid minimum standards with respect to intensity and light distribution. The required horizontal and vertical light intensity distribution profiles cannot be imaged precisely enough, which means that, in order to be able to satisfy the conditions within the one solid angle region, the outer illuminations of aircraft equipped with conventional incandescent lamps emit a light intensity much higher than the standards in the remaining solid angle regions. In other words, the efficiency of these lights is not optimal.

From U.S. Patent No. 5,608,290, a flash lamp is known where the LEDs emit light transversely to the radiation direction of the lamp. Within the light, this light is deviated via a cone reflector surface and subsequently passes a lens.

From WO-A-00/71417, an airplane light is known where the light from LEDs is guided into a desired radiation direction via an optical element. The LEDs and the optical element are surrounded by a transparent cover.

Finally, JP-A-2001 291 901 shows a light source where LEDs are embedded in the material of a lens body.

SUMMARY OF THE INVENTION

It is the object of the invention to provide an anticollision light for aircraft, particularly airplanes, which is provided with a simplified system for the light distribution in space while using LEDs.

In order to solve this object, the invention suggests an anticollision light for aircraft, particularly airplanes, which is provided with

- a holding body with an outer side,
- several LEDs arranged at the outer side the light radiation directions of which point away from the holding body,

- a drive unit for the pulse-like drive of at least some of the LEDs, and
- a refractive optical element for generating a desired spatial distribution of the light of the LEDs,
- the refractive optical element surrounding the holding body at least in the region of the LEDs.

In order to achieve the vertical light distribution required for anticollision lights, a refractive optical element, namely, e.g., a lens system, is hence, according to the invention, used with the anticollision light tobe described here, which substantially radiates light over 360°. This refractive optical element surrounds a holding body holding several LEDs at least in that region in which the LEDs are arranged at the holding body. The holding body itself has an outer side on which the LEDs are located, either for emitting light all around or only in a portion of the outer surface for emitting light in a partial region. The LEDs radiate their light substantially in that direction in which the light emerges from the light. There are no deviating elements or the like in the interior of the light. The light of the LEDs rather passes only the refractive optical element to directly emerge from the light. The LEDs are driven in a pulse-like manner by a drive unit. It is conceivable that not all LEDs operate during a pulsed operation. It is useful if the anticollision light is designed such that even in case of failure of a LED or a LED module, still sufficient light is emitted with respect to the horizontal light intensity distribution.

In an advantageous embodiment of the invention, it is provided that the refractive optical element is configured as a spherical or non-spherical lens or as a cylinder, free-form or Fresnel lens. Alternative configurations of the refractive optical element are, e.g., prism structures serving to direct the light like lenses.

Like every light, the anticollision light also comprises a so-called light disc separating the portion from which light emerges from the light from the environment. It is useful if the refractive optical element is simultaneously configured as a light disc so that the overall number of individual components of the anticollision light is correspondingly reduced.

In an advantageous embodiment of the invention, it is provided that the LEDs are arranged at circumferential surfaces at the holding body and are divided up into at least two parallel planes. Alternatively, the LEDs can also be arranged in one common plane only. Within this plane or these planes, the LEDs determine the horizontal light intensity distribution that should be constant over 360° and have a minimum value.

When the LEDs are arranged in several planes, it is advantageous when the LEDs of the individual planes have different portions of the refractive optical element allocated thereto. Within these portions, the optical effect of the refractive optical element can be the same or different. The latter makes it possible to generate any (vertical) light intensity distributions by configuring these areas correspondingly. Thereby, it is possible to adapt one and the same holding body together with the plurality of LEDs to different (vertical) light intensity distributions by using differently shaped refractive optical elements.

In an advantageous embodiment of the invention, it is further provided when the refractive optical element is configured as a cap element that is put on the holding body and comprises a lid portion as well as a circumferential edge portion joined thereto which surrounds the plurality of LEDs and, if necessary, comprises the refractive optical properties up into the transition portion towards the lid portion.

As an LED, single LEDs can be used which have a semiconductor substrate with a single light-emitting portion per housing and are individually housed; alternatively or preferably, however, LED modules are used which have a semiconductor substrate with a plurality of light-emitting portions per housing, which are particularly arranged in the form of an array.

Advantageously, the outer side of the holding body is cylindrical at least in a partial area. This outer surface need not necessarily be circular cylindrical, but will preferably have a substantially circular cylindrical configuration. Alternative embodiments are, for example, an elliptic course of the cylindrical outer surface. In the scope of this invention, a "cylindrical surface" therefore means a surface that is cylindrical in the mathematical sense, i.e., spanned by a straight line when this straight line is displaced in space along a closed (lead) curve.

BRIEF DESCRIPTION OF THE DRAWINGS

Hereinafter, the invention will be explained in detail with respect to diverse embodiments with reference to the drawing. In the Figures:

Fig. 1	shows a diagonal cross section through a first embodiment of an anticollision light for an airplane,
Fig. 2	shows a diagonal cross section through a second embodiment of an anticollision light for an airplane,
Fig. 3	shows a diagonal cross section through a third embodiment of an anticollision light for an airplane.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT OF THE INVENTION

Fig. 1 shows a first embodiment 10 of an anticollision light for airplanes. The light 10 comprises a disc-shaped holding body 12 provided with a cylindrical outer surface 14. On this outer surface 14, there is a plurality of LEDs or LED modules 16 with housings acting as optical lenses 17, emitting their light in a radially outwardly directed manner. These LEDs 16 operate in pulsed operation and to this end, they are driven by a drive unit 18 with several electric and electronic circuit components 22, respectively, which are arranged on a carrier plate 20. The carrier plate 20 and the holding body 12 rest on a holding plate 24.

On the holding body 12, a refractive optical element 26 of a transparent material is put which, as a cap element, is provided with a lid portion 28 and an edge portion 30 with a substantially cylindrical outer surface 32. Within the edge portion 30 as well as, if necessary, in the transition portion to the lid portion 28, the optical element 26 has refractive properties selected such that a desired light intensity distribution appears in vertical direction, i.e., vertically to the plane 34 within which the LEDs 16 are arranged along the circumferential cylindrical outer surface 14.

Fig. 2 shows an alternative embodiment of an anticollision light 10' the individual components of which are denoted with the same reference characters in Fig. 2 as in the case of the light 10 of Fig. 1 as long as they are identical and have the same effect, respectively.

The difference of the anticollision light 10' of Fig. 2 to that of Fig. 1 lies in the configuration of the edge portion 30 of the cap-like refractive optical element 26. While the outer side of the optical element 26 is substantially cylindrical in the edge portion 30 in the embodiment according to Fig. 1, the edge portion of the cap-like optical element of the light 10' of Fig. 2 has a convexly curved outer surface 32.

In Fig. 3, a further embodiment of an anticollision light 10" is illustrated. Here, it also applies that in Fig. 3, the same reference characters are used as in Figs. 1 and 2 as far as the elements or parts denoted in detail are identical and have the same effect, respectively.

The characteristic feature of the anticollision light 10" of Fig. 3 consists in that the light-emitting diodes 16 are arranged within two planes 34 parallel to each other. Each plane 34 of the light-emitting diodes 16 has a separate section 36,38 of the edge portion 30 of the cap-shaped optical element 26 allocated thereto. In both portions 36,38, the outer surface 32 of the edge portion 30 comprises outwardly curved sections which are possibly different in shape and in radial extension. Both convexly shaped portions 36,38, e.g., may also be identical.

Although the invention has been described and illustrated with reference to specific illustrative embodiments thereof, it is not intended thatthe invention be limited to those illustrative embodiments. Those skilled in the art will recognize that variations and modifications can be made without departing from the true scope of the invention as defined by the claims that follow. It is therefore intended to include within the invention all such variations and modifications as fall within the scope of the appended claims and equivalents thereof.